01/06/80

IN THE UNITED STATES
PATENT AND TRADEMARK OFFICE

PATENT APPLICATION

Donald Edgar Blahut
James D. Bobeck
Robert William Dalton
Enrique Hernandez-Valencia
Roger Henry Levy
Ronald L. Sharp

Prior Application:
 Serial No. 08/991,735
 Filing Date: December 16, 1997
 Group Art Unit: 2756
 Examiner: M. Geckil
 Status: Pending

Case 48-5-3-16-4-7

ASSISTANT COMMISSIONER FOR PATENTS
 WASHINGTON, D. C. 20231

SIR:

CONTINUATION/DIVISIONAL APPLICATION UNDER 37 CFR § 1.53(b)

SIR:

This is a request for filing a ☒ continuation ☐ divisional application under 37 CFR § 1.53(b) of prior Application Serial No. 08/991735, filed on December 16, 1997, entitled Internet Protocol Based Network Architecture For Cable Television Access with Switched Fallback

Enclosed are the following papers relating to the above-identified application:

1. ☒ Specification (Total Pages: _13_)

2. ☒ Drawings (Total Sheets: _4_)

3. ☒ Copy of "Declaration and Power of Attorney" from prior application (Total Pages: _8_)

4. ☐ Newly executed "Declaration and Power of Attorney" (if **adding** inventors) (Total Pages: ____)

5. ☐ Newly executed "Assignment and Agreement" (if **adding** inventors) (Total Pages: ____)

6. ☒ Incorporation By Reference
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 3, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.

7. ☐ **DELETION OF INVENTOR(S)**
Signed statement attached (under 37 CFR § 1.63(d)(2)) deleting inventor(s) named in the prior application

8. ☐ Information Disclosure Statement

9. ☐ **Copy** of "Extension of Time"

10. ☐ Other:

11. ☒ Cancel the following original claims in the prior application before calculating the filing fee: ___ Cancel claims 3 and 6

PT 17A (12/97)

CLAIMS AS FILED IN THE PRIOR APPLICATION, LESS ANY CLAIMS CANCELLED ABOVE				
	NO. FILED	NO. EXTRA	RATE	CALCULATIONS
Total Claims	17-20 =	0	x $22 =	0
Independent Claims	7-3 =	4	x $82 =	328
Multiple Dependent Claims(s), if applicable			+ $270 =	
Basic Fee				$790
				$1118
			TOTAL FEE	

12. ☒ Amend the specification by inserting before the first line this sentence:

This is a ☒ continuation ☐ divisional of Application Serial No. __08/991,735__ filed on __December 16, 1997__.

13. ☒ Preliminary Amendment

14. Amendment Fee:

☐ No additional fee is required.

☒ An additional amendment fee is calculated as follows:

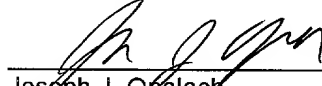| CLAIMS AS AMENDED						
	Claims Remaining After Amendment		Highest No. Previously Paid For (from PT 17A)	Present Extra	Rate	Additional Fee
Total Claims for Fee Purposes	30	minus	0	10	x $22	220
Independent Claims	14	minus	4	10	x $82	820
Multiple Dependent Claim(s) first presented with this amendment, if applicable.					+ $270	
TOTAL ADDITIONAL FEE FOR THIS AMENDMENT:						$1040

15. Please charge the total amount of $__1040__ to **Lucent Technologies Deposit Account No. 12-2325**.

Duplicate copies of this letter are enclosed. In the event of non-payment of improper payment of a required fee, the Commissioner is authorized to charge or to credit **Deposit Account No. 12-2325** as required to correct the error.

PT 17B (12/97)

The Assistant Commissioner for Patents is hereby authorized to treat any concurrent or future reply, requiring a petition for extension of time under 37 CFR § 1.136 for its timely submission, as incorporating a petition for extension of time for the appropriate length of time if not submitted with the reply.

Please address all correspondence to **Docket Administrator (Room 3C-512), Lucent Technologies Inc., 600 Mountain Avenue, P.O. Box 636, Murray Hill, New Jersey 07974-0636**. However, telephone calls should be made to me at (732) 949-1708.

Respectfully,

Joseph J. Opalach
Attorney for Applicant(s), Reg. No. 36229

Date: January 5, 2000

Lucent Technologies Inc.
600 Mountain Avenue (Room 3C-512)
P.O. Box 636
Murray Hill, New Jersey 07974-0636

PT 17C (12/97)

IN THE UNITED STATES
PATENT AND TRADEMARK OFFICE

Patent Application

Inventor(s) Donald E. Blahut
James D. Bobeck
Robert W. Dalton
Enrique Hernandez-Valencia
Roger H. Levy
Ronald L. Sharp

Serial No. **Case** 48-5-3-16-4-7

Filing Date **Art Unit**

Examiner

Title Internet Protocol Based Network Architecture For Cable Television Access with Switched Fallback

ASSISTANT COMMISSIONER FOR PATENTS
   BOX: APPLICATION
   WASHINGTON, D. C. 20231

SIR:

PRELIMINARY AMENDMENT FOR CONTINUED PROSECUTION UNDER 37 C.F.R. 1.53(b)

This priliminary amendment is submitted with the continuing prosecution application filed for the above-identified application.

In the claims:

Current claim 1:

1   1. A method for use in providing Internet service to an endpoint, the method
2   comprising the steps of:
3   specifying routing information for an endpoint, wherein the routing information
4   specifies primary and alternative Internet Protocol (IP) addresses; and
5   communicating data to the endpoint using the specified primary IP address
6   except during periods of service interruption in which one of the alternative IP
7   addresses are used.

Current claim 2:

1   2. The method of claim 1 wherein the communicating data step further
2 comprises the steps of:
3   detecting the service interruption;
4   establishing an IP tunnel to the endpoint using one of the alternative IP
5 addresses;
6   and
7   forwarding the data via the IP tunnel to the endpoint.

Cancel claim 3.

Current claim 4:

1   4. A method for use in providing Internet service to an endpoint via a primary
2 communications channel, the method comprising the steps of:
3   storing a routing table comprising an first Internet Protocol (IP) address
4 associated with routing data to an endpoint via the primary communications channel
5 and a second IP address associated with routing data to the endpoint over a secondary
6 communications channel; and
7   routing data to the endpoint as a function of the routing table such that during
8 periods of service interruption on the primary communications channel data is routed to
9 the endpoint via the secondary communications channel, whereas data is routed to the
10 endpoint via the primary communications channel otherwise.

Current claim 5:

1   5. The method of claim 4 wherein the routing data step further comprises the
2 steps of:
3   detecting the service interruption;
4   establishing an IP tunnel to the endpoint using the second IP address;
5   and
6   forwarding the data via the IP tunnel to the endpoint.

Cancel claim 6.

Current claim 7:

1   7. A method of communicating over a cable television (CATV) access network

2   having a cable modem termination system (CMTS) interface, the method comprising

3   the steps of:

4   establishing a connection between the CMTS and a distant cable modem (CM);

5   storing routing information associated with the connection, the routing

6   information including at least a CM identifier, an identity of an RF link on the CATV

7   access network over which the CMTS forwards data packets to the CM, and a tunnel

8   interface identifier over which the CMTS forwards data packets to the CM over a

9   different network; and

10   communicating data packets to the CM by translating the CM identifier to either

11   the identified RF link or the tunnel interface identifier, wherein the tunnel is invoked in

12   the event of a CATV interface failure.

Current claim 8:

1   8. The method of claim 7 wherein CATV access network provides one-way, or

2   downstream, communications to the CM.

Current claim 9:

1   9. The method of claim 7 wherein CATV access network provides two-way

2   communications to the CM.

Current claim 10:

1   10. The method of claim 7 wherein the CM identifier over the CATV network is

2   logically derived from a CMTS subnetwork identifier of the CMTS.

Current claim 11:

1   11. The method of claim 7 wherein the CM identifier over the different network is

2   logically derived from an Internet Service Provider (ISP) subnetwork identifier of a

3   Network Access Server (NAS) of the ISP.

Current claim 12:

1   12. Apparatus for use in providing Internet service to an endpoint, the apparatus

2   comprising:

3   a device for (a) specifying routing information for an endpoint, wherein the
4   routing information specifies primary and alternative Internet Protocol (IP) addresses,
5   and (b) communicating data to the endpoint using the specified primary IP address
6   except during periods of service interruption in which one of the alternative IP
7   addresses are used.

Current claim 13:

1   13.   The apparatus of claim 12 wherein the device is a part of a cable television
2   network (CATV).

Current claim 14:

1   14.   Apparatus for use in providing Internet service to an endpoint, the apparatus
2   comprising:
3   a device for routing data to the endpoint as a function of a routing table stored
4   therein such that during periods of service interruption on a primary communications
5   channel data is routed to the endpoint via a secondary communications channel,
6   whereas data is routed to the endpoint via the primary communications channel
7   otherwise.

Current claim 15:

1   15.   The apparatus of claim 14 wherein the device is a part of a cable television
2   network (CATV).

Current claim 16:

1   16.   A system for use in providing Internet service, the system comprising:
2   a cable head-end router for providing Internet Protocol (IP) packets intended for
3   subsequent conveyance over a primary channel; and
4   a cable modem data termination system responsive to the provided IP packets
5   for routing the IP packets to an endpoint as a function of a routing table stored therein
6   such that during periods of service interruption on the primary communications channel
7   the IP packets are routed to the endpoint via a secondary communications channel,
8   whereas the IP packets are routed to the endpoint via the primary communications
9   channel otherwise.

Current claim 17:

1   17.   A system for use in providing Internet service, the system comprising:

2   a cable head-end router for providing Internet Protocol (IP) packets that include

3   a destination field having a value associated with a first IP address; and

4   a cable modem data termination system responsive to the provided IP packets

5   for communicating the IP packets to the endpoint using the first IP address except

6   during periods of service interruption in which an alternative IP address is used.

New claims 18 – 32:

1   --18. A method for use in providing Internet service to an endpoint, the method

2   comprising the steps of:

3   specifying routing information for an endpoint, wherein the routing information

4   specifies primary and alternative Internet Protocol (IP) addresses; and

5   communicating data to the endpoint using the specified primary IP address over

6   a first cable-based communications channel except during periods of service

7   interruption in which one of the alternative IP addresses are used for communicating

8   over a second non-cable-based communications channel.--

1   --19. The method of claim 18 wherein the communicating data step further

2   comprises the steps of:

3   detecting the service interruption;

4   establishing an IP tunnel to the endpoint using one of the alternative IP

5   addresses;

6   and

7   forwarding the data via the IP tunnel to the endpoint.--

1   --20. A method for use in providing Internet service to an endpoint via a primary

2   communications channel, the method comprising the steps of:

3   storing a routing table comprising an first Internet Protocol (IP) address

4   associated with routing data to an endpoint via the primary communications channel

5   and a second IP address associated with routing data to the endpoint over a secondary

6   communications channel; and

7   routing data to the endpoint as a function of the routing table such that during

8   periods of service interruption on the primary communications channel data is routed to

9   the endpoint via the secondary communications channel, whereas data is routed to the

10   endpoint via the primary communications channel otherwise and wherein the primary

11   communications channel and the secondary communications channel are supported by

12   physically different communications mediums.--

1   --21. The method of claim 20 wherein the routing data step further comprises

2 the steps of:

3   detecting the service interruption;

4   establishing an IP tunnel to the endpoint using the second IP address;

5   and

6   forwarding the data via the IP tunnel to the endpoint.--

1   --22. A method of communicating over a cable television (CATV) access

2 network having a cable modem termination system (CMTS) interface, the method

3 comprising the steps of:

4   establishing a connection between the CMTS and a distant cable modem (CM);

5   storing routing information associated with the connection, the routing

6 information including at least a CM identifier, an identity of an RF link on the CATV

7 access network over which the CMTS forwards data packets to the CM, and a tunnel

8 interface identifier over which the CMTS forwards data packets to the CM over a

9 switched telephone network; and

10   communicating data packets to the CM by translating the CM identifier to either

11 the identified RF link or the tunnel interface identifier, wherein the tunnel is invoked in

12 the event of a CATV interface failure.--

1   --23. The method of claim 22 wherein CATV access network provides one-way,

2 or downstream, communications to the CM.--

1   --24. The method of claim 22 wherein CATV access network provides two-way

2 communications to the CM.--

1   --25. The method of claim 22 wherein the CM identifier over the CATV network

2 is logically derived from a CMTS subnetwork identifier of the CMTS. --

1   --26. The method of claim 22 wherein the CM identifier over the switched

2 telephone network is logically derived from an Internet Service Provider (ISP)

3 subnetwork identifier of a Network Access Server (NAS) of the ISP.--

1   --27. Apparatus for use in providing Internet service to an endpoint, the

2 apparatus comprising:

3   a device for (a) specifying routing information for an endpoint, wherein the

4 routing information specifies primary and alternative Internet Protocol (IP) addresses,

5   and (b) communicating data to the endpoint using the specified primary IP address over
6   a first cable-based channel except during periods of service interruption in which one of
7   the alternative IP addresses are used for communicating data over a second non-
8   cable-based communications channel.--

1   --28. The apparatus of claim 27 wherein the device is a part of a cable
2   television network (CATV).--

1   --29. Apparatus for use in providing Internet service to an endpoint, the
2   apparatus comprising:
3   a device for routing data to the endpoint as a function of a routing table stored
4   therein such that during periods of service interruption on a primary communications
5   channel data is routed to the endpoint via a secondary communications channel,
6   whereas data is routed to the endpoint via the primary communications channel
7   otherwise and wherein the primary communications channel is physically different from
8   the secondary communications channel.--

1   --30. The apparatus of claim 29 wherein the device is a part of a cable
2   television network (CATV).--

1   --31. A system for use in providing Internet service, the system comprising:
2   a cable head-end router for providing Internet Protocol (IP) packets intended for
3   subsequent conveyance over a primary cable channel; and
4   a cable modem data termination system responsive to the provided IP packets
5   for routing the IP packets to an endpoint as a function of a routing table stored therein
6   such that during periods of service interruption on the primary cable channel the IP
7   packets are routed to the endpoint via a secondary non-cable communications channel,
8   whereas the IP packets are routed to the endpoint via the primary cable channel
9   otherwise.--

1   --32. A system for use in providing Internet service, the system comprising:
2   a cable head-end router for providing Internet Protocol (IP) packets that include
3   a destination field having a value associated with a first IP address; and
4   a cable modem data termination system responsive to the provided IP packets
5   for communicating the IP packets to the endpoint over a cable-based communications
6   channel using the first IP address except during periods of service interruption in which

7 an alternative IP address is used for communicating the IP packets to the endpoint over
8 a non-cable-based communications channel.--

REMARKS

This is a continuation application of Application No. 08/991735.

Applicants have added new claims 18 – 32 for consideration, of which claims 18, 20, 22, 27, 29, 31 and 32 are independent:

- Claim 18 requires a first cable-based communications channel and a second non-cable-based communications channel (lines 6 - 8);

- Claim 20 requires that the primary communications channel and the secondary communications channel be supported by physically different communications mediums (lines 10 - 12);

- Claim 22 requires a CATV access network and a switched telephone network (lines 6 - 9);

- Claim 27 requires a first cable-based channel and a second non-cable-based communications channel (lines 6 - 8);

- Claim 29 requires that the primary communications channel is physically different from the secondary communications channel (lines 6 - 8);

- Claim 31 requires a primary cable channel and a secondary non-cable communications channel (lines 6 - 9); and

- Claim 32 requires a cable-based communications channel and a non-cable-based communications channel (lines 5 – 8).

Claims 1 – 17 have been rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 5,903,558 issued May 11, 1999 to Jones et al. (the Jones reference) in the Office Action of December 12, 1999 with respect to the parent, Application No. 08/991735. Applicants respectfully maintain their disagreement as stated in applicants' response of October 5, 1999.

Applicants suggest the Examiner simply provide column and line numbers for those portions of the Jones reference that the Examiner asserts anticipate applicants'

- 8 -

claimed elements and then provide citations for those portions of the Jones reference that the Examiner asserts render applicants' claimed elements obvious.

For example, consider applicants' claim 7, if the Examiner states that the Jones reference "taught the invention <u>substantially as claimed</u>" (emphasis added), it would be helpful to applicants if the Examiner could specifically state what portion of the Jones reference relates to the "establishing step," "storing routing information step," and "communicating data packets step."

Additionally, applicants note that the Examiner states the following:

Jones et al did not specified due to the scope of their teaching that their system used routing table for switching from the primary line to the secondary line, or that the primary lines used different IP numbers but they stated that it would be obvious to one of ordinary skill in the art that these were the well known features of the art (e.g., see column 6, line 2 et seq.)

However, col. 6, lines 1 – 17 of the Jones reference states:

With reference now to FIG. 4, a block diagram of a data processing system that may be employed to implement a router in either head-end 102 or at a CAU 126 is depicted according to the present invention. At head-end 102 and at CAU 126, the routing function may be implemented using data processing system 400, which includes processor 402, random access memory (RAM) 404, read only memory (ROM) 406, storage device (SD) 408, and display device 410, all connected by bus 412 according to the present invention. *One having ordinary skill in the art will recognize that the elements of data processing system 400 are conventional and operate in a conventional manner.* Router 210 in FIG. 2 and router 308 in FIG. 3 use some or all of the components depicted in FIG. 4 according to the present invention. Alternatively, the functions provided by router 210 or router 308 may be implemented in an application specific integrated
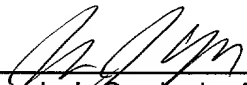
circuit (ASIC) according to the present invention. Data processing system 400 may be implemented using a number of data processing systems, such as a personal computer, a work station, or a main frame computer system. (Emphasis added.)

Nowhere can applicants find in the above-cited excerpt from the Jones reference any statement, or suggestion, to support the Examiner's comment that "switching from the primary line to the secondary line, or that the primary lines used different IP numbers but they stated that it would be obvious to one of ordinary skill in the art that these were the well known features of the art."

Applicants request that the Examiner clarify his argument with respect to column 6, lines 2 et seq. of the Jones reference so that applicants can better appreciate the Examiner's point.

In view of the foregoing, it is respectfully submitted that all remaining claims are now in condition for allowance and reconsideration is requested. If the Examiner believes that prosecution would be expedited by direct discussion, a telephone call to the undersigned would be welcomed.

Respectfully,

Joseph J. Opalach, Attorney
Reg. No. 36229
732-949-1708

Date: January 5, 2000
Lucent Technologies Inc.
600 Mountain Avenue (Room 3C-512)
P.O. Box 636
Murray Hill, New Jersey 07974-0636

Internet Protocol Based Network Architecture for Cable Television Network Access with Switched Fallback

Cross-Reference to Related Applications

Related subject matter is disclosed in the following co-pending, commonly
5   assigned, U.S. Patent applications of Bobeck et al., serial No. 08/852971, filed on
June 14, 1996; and Heer et al., serial No. 08/837423, filed on June 14, 1996.

Field of the Invention

This invention relates generally to communications and, more particularly, to
packet communications systems.

10   ## Background of the Invention

Today, access to the Internet is available to a wide audience through the public
switched telephone network (PSTN). Typically, in this environment, a user accesses the
Internet though a full-duplex dial-up connection through a PSTN modem, which may offer
data rates as high as 56 thousand bits per second (56 kbps) over the local-loop plant.

15   However, in order to increase data rates (and therefore improve response time),
other data services are either being offered to the public, or are being planned, such as
data communications using full-duplex cable television (CATV) modems, which offer a
significantly higher data rate over the CATV plant than the above-mentioned PSTN-based
modem. In addition, hybrid networks, where the amount of bandwidth available in one
20   direction of the connection is significantly higher than on the reverse direction, are being
planned. In a hybrid network, the user accesses the Internet by transmitting data via a
PSTN-based modem and receiving data via the CATV-based modem. This hybrid
network is based upon a model where in the upstream direction, i.e., to the Internet, the
amount of data to be transmitted is small — hence a lower data rate is permissible —
25   whereas in the downstream direction, i.e., from the Internet, the amount of data to be
received is large — hence a higher data rate is desirable.

Irrespective of the data communications architecture, when accessing the Internet
an Internet Protocol (IP) address is associated with the endpoint receiving the data. For
example, in the above mentioned hybrid architecture, downstream IP packets are
30   transmitted to an IP address associated with the CATV equipment that provides the data
to the end user. Consequently, the user experiences an interruption in service when a fault
occurs in the CATV plant.

Summary of the Invention

Therefore, and in accordance with the invention, we provide a fall-back technique for use in any IP-based data communications architecture. In particular, a routing table specifies alternate IP connections in the event of a service interruption. As a result, a user
5   is not aware of a service interruption other than, perhaps, experiencing an increase in response time in some situations due to a drop in data rates.

In an embodiment of the invention, a user accesses the Internet through a hybrid data communications system architecture in which upstream service is provided via the local loop of the PSTN and downstream service is provided via a CATV network. The
10   Cable Modem Data Termination system (CMTS) includes a routing table. Upon detection of a CATV service interruption, the CMTS re-routes IP traffic destined for a first destination IP address (IP1) associated with the user to a different IP address (IP2), or endpoint, as a function of the routing table. In this instance, the IP2 address is associated with equipment that provides downstream IP service to the user via the local loop of the
15   PSTN.

Brief Description of the Drawing

FIG. 1 shows an illustrative hybrid data communications system embodying the principles of the invention;

FIG. 2 shows an alternative "protocol stack" view of the hybrid communications
20   system of FIG. 1;

FIG. 3 shows an illustrative method embodying the principles of the invention; and

FIG. 4 shows another illustrative method embodying the principles of the invention.

Detailed Description

25   An illustrative communications system embodying the principles of the invention is shown in FIG. 1. Other than the inventive concept, the elements shown in FIG. 1 are well-known and will not be described in detail. Also, although the illustrative embodiment is representative of a hybrid network architecture, the inventive concept is applicable to any IP-based network architecture.

30   As noted above, communications system 100 is representative of a hybrid network architecture in which a user associated with PC 110 accesses Internet services. In particular, PC 110 (also referred to herein as a "home appliance") provides upstream transmissions via PSTN 140 and receives downstream transmissions via a CATV network. Cable TV network access is provided by an MSO (Multi-Service Operator) (not shown).
35   In this context, it is assumed the MSO provides (besides the traditional CATV access

network facilities exemplified by communications link 117) CATV head-end 170 and cable modem 115. This CATV network arrangement is also referred to herein as a cable data network (CDN). PC 110 is representative of data terminal equipment and is coupled via communications link 116 to cable modem (CM) 115. Communications link 116 is

5 representative of well-known interconnection technology between a data terminal equipment and data communications equipment, e.g., an ethernet local area network (LAN) connection such as 10BaseX or a PC bus. CM 115 provides the access interface to the CDN for downstream transmission and the PSTN for upstream transmission. (As is known in the art, some 2-way traffic may be required over the PSTN and CDN networks,

10 e.g., between cable modem 115 and opposing data communications equipment, for connection initialization and control purposes but this traffic is transparent to PC 110.)

Internet access is provided by an Internet Service Provider (ISP). In the context of FIG. 1, it is assumed an ISP provides ISP network 175, which includes a CDN access router (not shown) attached to communications link 132, and network access server

15 (NAS) 145, which includes a point-of-presence (POP) router as known in the art. Although NAS 145 and CATV head-end 170 could be co-located, it is assumed for this example that NAS 145 is not co-located with CATV head-end 170. For example, it is assumed that the above-mentioned MSO and ISP Service provider are different entities even though this is not relevant to the inventive concept.

20 In the downstream direction, CM 115 is coupled to CATV head-end 170 via cable facility 117, which is, e.g., a CATV radio-frequency (RF) coax drop cable and associated facilities. CATV head-end 170 provides services to a plurality of downstream users (not shown) and comprises cable modem data termination system (CMTS) 120 and head-end (HE) router 125. (CMTS 120 is coupled to HE router 125 via an Ethernet 100BaseX

25 connection (not shown).) CMTS 120 terminates the CATV RF link with CM 115 and implements data link protocols in support of the provided residential service (described below). Given the broadcast characteristics of the RF link, multiple residential customers and, hence, potentially many home-based LANs may be serviced from the same CMTS interface. (Also, although not shown, it is assumed that the CATV network includes a

30 plurality of CMTS/HE router pairs.)

In the upstream direction, CM 115 is coupled to NAS 145 via PSTN 140, and telecommunications facilities 141 and 142. The latter are illustratively, local loops.

Another view of the communications system of FIG. 1 is shown in FIG. 2, which illustrates the associated communications stacks (as known in the art). The IP

35 communications between PC 110 and CM 115 is supported by IEEE 802.3 over an Ethernet 10BaseX connection. In addition, CM 115 supports an address resolution

protocol (ARP). The IP communications between CM 115 and NAS 145 is supported by the point-to-point protocol (PPP) over the plain-old-telephone-service (POTS). The IP communications between CM 115 and CMTS 120 is supported by the media access control (MAC) protocol over a hybrid-fiber-coax physical layer (PHY_{HFC}). The IP
5 communications between CMTS 120 and HE router 125 is supported by IEEE 802.3 over an Ethernet 100BaseX connection. The IP communications between HE router 125 and Internet 180 is supported by asynchronous transfer mode (ATM) over a synchronous optical network (SONET). The IP communications between NAS 145 and Internet 180 is supported by asynchronous transfer mode (ATM) over a synchronous optical network
10 (SONET).

In this approach, CM 115 and CMTS 120 are routers such that CMTS 120 does not need to be aware of the MAC address of the home appliance (PC 110). As such, MAC address resolution is supported by CM 115 as shown in FIG. 2 with CM 115 supporting ARP. (It should be noted that IP address resolution could also be supported
15 by a different device (not shown) on the home LAN). In this example, it is assumed that CM 115 is able to ARP for the MAC address of a target home appliance (or, provide any other mechanism to associate a MAC address to a home appliance IP address). This type of architecture enables CMTS 120 to treat its connection to the CM 115 as a virtual point-to-point link.

20 As described above, this hybrid architecture supports downstream communications over the CATV network and upstream communications over the PSTN by associating different IP subnetworks with each of the different cable modem interfaces. Specifically, the CATV interface of CM 115 is logically associated with the IP subnetwork of CMTS 120. This assignment establishes the logical point of attachment of the cable modem to
25 the CDN. (In this example, it is assumed that each home IP subnetwork is associated with a particular CMTS/HE router pair of the CATV network. For simplicity, and as noted above, only one CMTS/HE router pair is shown in FIGs. 1 and 2). Similarly, the PSTN interface of CM 115 is logically associated with the IP subnetwork of NAS 145. For example, the IP address of CM 115 associated with CMTS 120/HE router 120 is $x.y.z.1$,
30 where the $x.y$ portion represents the network address prefix (here the CDN network), and the portion $x.y.z$ represents a particular subnetwork prefix. Similarly, with respect to NAS 145, the IP address of CM 115 is $a.b.c.1$, where the $a.b$ portion represents the network address prefix (here the ISP network), and the portion $a.b.c$ represents a particular subnetwork prefix. This assignment establishes the logical point of attachment of the
35 cable modem to the PSTN. Given that the CDN provides the path for the downstream information rather than the PSTN link, PC 110 uses IP addresses that have the IP

subnetwork address identifier of the CMTS 120 as a prefix when communicating with target destinations, e.g., an endpoint (not shown) coupled to Internet 180. In this context, CMTS 120 is also known as the "homing" CMTS with respect to PC 110. As such, home appliances appear to the external world as IP subnetworks of the homing CMTS/HE

5   router. For example, assume that IP1 is representative of the subnetwork address of CMTS 120 and that IP2 is representative of the subnetwork address NAS 145. As known in the art, an IP packet comprises (among other elements) a "source IP address" field to identify the sender and a "destination IP address" field to identify the endpoint. Here, in transmitting IP packets upstream, PC 110 uses IP1 as a prefix value of the "source IP

10   address" field, not IP2. These upstream IP packets are routed, e.g., by ISP Network 175, to the endpoint associated with the value of the "destination field" in these IP packets. The endpoint responds with traffic using the value in the received "source IP address" field, which in this case includes IP1 as a prefix value. As a result, the ISP Network 175 routes this downstream traffic to IP1, which uses the CDN. (For additional information

15   with respect to inter-domain routing see, e.g., "Classless Inter-Domain Routing (CDIR): an Address Assignment and Aggregation Strategy," Internet Engineering Task Force (IETF) Request for Comment (RFC) 1519, September 1993, by Fuller et al.)

        This approach significantly simplifies Operations, Administration, Maintenance and Provisioning (OAM&P) requirements for the CDN service provider since supporting data

20   services over the CATV network, including IP multicast, is then not any different than supporting IP services over a conventional router network. Another benefit from this approach is that the IP routing table size (described below) for the CMTS grows proportionally to the number of RF links, rather than proportional to the number of CMs or home appliances, by making all home LANs share the IP subnetwork prefix of the

25   homing CMTS.

        An "Internet connection" is established as in the prior art by, e.g., the user at PC 110 "dialing" a predetermined telephone number associated with NAS 145. The latter couples the user at PC 110 to Internet 180 subsequent to appropriate initialization procedures as known in the art, e.g., data communications equipment handshaking,

30   security verification via, e.g., a "log-on" procedure, etc. (For simplicity, the corresponding data communications equipment located within NAS 145 is not shown).

        Under normal operating conditions, outbound traffic from PC 110 is forwarded to CM 115. After the above-mentioned initial set up of a point-to-point link to the subscribed ISP over the PSTN, including appropriate authentication and authorization

35   steps, CM 115 relays such upstream traffic to NAS 145 via PSTN 140. Such upstream traffic finds its way to its intended destination (not shown) by standard IP routing

procedures invoked by ISP Network 175 and other ISPs (not shown). Downstream traffic bound to PC 110 is forwarded to CM 115 via CMTS 120. In this context, the link between CMTS 120 and CM 115 via cable link 117 is referred to as the primary communications channel.

5   Unfortunately, should the cable link to CM 115 fail, then CMTS 120 can no longer forward IP traffic addressed to PC 110. Therefore, and in accordance with the invention, we provide a fall-back technique for use in any IP-based data communications architecture. In particular, a routing table specifies alternate IP connections in the event of a service interruption. As a result, a user is not aware of a service interruption other than,

10   perhaps, experiencing an increase in response time in some situations due to a drop in data rates.

       An illustrative method embodying the principles of the invention is shown in FIG. 3. In step 305, CMTS 120 detects a service interruption with respect to the downstream cable link to CM 115. (Cable Network management/monitoring functions are well-known

15   and will not be described herein). Following detection of the service interruption, CMTS 120 establishes an IP tunnel to CM 115 in step 310 (described further below). In this example, the IP tunnel allows CMTS 120 to re-route any downstream traffic to CM 115 via the PSTN 140. In step 315, CMTS 120 forwards traffic via this IP tunnel to CM 115. The latter extracts the traffic from the tunnel and "relays" it to the respective home

20   appliance. In this context, the link between CMTS 120 and CM 115 via PSTN 140 is referred to as the secondary communications channel. Note also that the CMTS IP tunnel to the CM may also be established during the CM log-on procedure to further expedite packet forwarding during re-routes.

       In order to perform this routing, CMTS 120 must know the IP address of CM 115

25   associated with the PSTN-side of the connection. As such, a routing table is stored within CMTS 120, e.g., within memory (not shown). An example of such a routing table is shown in Table 1, below.

TABLE 1. CMTS Routing Table

CM IP Address	RF Port ID	CM Tunnel IP Address
x.y.z.1	RF Port ID #n	a.b.c.1
:	:	:
x.y.z.k	RF Port ID #m	a.b.c.j

30   In Table 1, each CM is associated with 1) an IP address on the CDN, 2) an associated RF port identification (ID) on the CDN, and 3) an associated alternative IP

address for use during a service interruption. As described above, the IP address associated with the CM has a prefix value equal to the IP subnetwork address identifier of the "homing" CMTS. In this example, the IP address of CM 115 has a prefix value $(x.y.z)$ equal to the IP subnetwork address identifier of CMTS 120. The RF port ID associates

5   the CM IP, at the physical level, with a particular port of CMTS 120. The CM Tunnel IP is the value of the IP address associated with the PSTN-side of the connection and has a prefix value equal to the IP subnetwork address identifier of NAS 145 $(a.b.c)$. As noted earlier, since there is only one such entry per CM, independently of the number of local appliances served by the CM, the management of this table is greatly simplified (in terms

10   of size and look up time).

The values populating the routing table, and particularly the CM Tunnel IP address value, are either statically determined or dynamically determined. In the former case, the IP address associated with the PSTN-side of the connection is entered into the table during administration of the account associated with the user of PC 110. That is, an

15   administrator (not shown) not only enters the IP address associated with the CDN-side into the system (as is currently performed), but also populates the routing table with the required values for the CM Tunnel IP Address. In the latter case, upon the initiation of a connection between NAS 145 and CM 115, CM 115 provides, via IP, a MAC HFC control message to CMTS 120, wherein the control message specifies the PSTN-side IP

20   address associated with CM 115. (MAC HFC control messages are known in the art.) Again, this information is known *a priori* to CM 115, as described above, since the user must have an IP address assigned by the ISP. As a result of the above routing table, CMTS 120 is able to identify the homing NAS in the ISP network to open an IP tunnel to redirect downstream traffic.

25   It should be noted that in the case of dynamically creating the routing table, table entries can also be dynamically removed any number of ways. For example, a table entry for a particular CM is removed upon receipt of a termination message from the CM (which, as upstream traffic, is transmitted over the PSTN-side of the connection). This ability to remove table entries for an IP endpoint provides a mechanism to limit the size of

30   the routing table. .

An illustrative method for processing downstream traffic for use in CMTS 120 in accordance with the principles of the invention is shown in FIG. 4. In step 350, CMTS 120 receives an IP packet and determines if that portion of the destination IP address matches the *a priori* IP subnetwork address identifier for CMTS 120. If there is no

35   match, CMTS 120 discards the received packet(s). (Alternatively, the received packet(s) may be routed to the next hop router (depending on whether the CMTS acts as either a

7

packet bridge or a router).) If there is a match, CMTS 120 compares that portion of the destination IP address to the routing table, in step 355, to determine if there is a match to an associated CM IP address served by CMTS 120. If there is no match, CMTS 120 discards the received packet. If there is a match, CMTS 120 checks on the status of the associated RF port ID in step 360. If the associated RF port ID is working, CMTS 120 routes the IP packet to the respective CM. If the associated RF port ID is unavailable, e.g., because of a hardware failure in that portion of the CATV plant, then CMTS 120 re-routes the IP packet to the alternate IP address indicated by the value in the "CM Tunnel IP" field.

In re-routing the downstream traffic, CMTS 120 encapsulates the received IP packet into another IP packet. The encapsulated IP packet is transmitted over HE router 125 for eventual routing to the PSTN, via the ISP modem pool (not shown) of NAS 145. In this encapsulation process, CMTS 120 uses its own IP address as the source IP address for the re-route packet and the CM tunnel IP address, which is the IP address of the CM on the PSTN-side of the connection (illustrated here by CM 115) as the destination IP address. The original IP packet is carried as the user data in the re-route packet. At the CM, the original IP packet is extracted from the payload of the re-routed packet. (IP encapsulation is known in the art, e.g., see "Generic Routing Encapsulation," IETF RFC 1701, Oct. 1994, by S. Hanks et al.; "IP in IP Tunneling," IETF RFC 1853, October 1995 by W. Simpson; "IP Encapsulation within IP," IETF RFC 2003, October 1996 by C. Perkins.)

In the case of shared media communications (Broadcast) or multicast group communications, the inventive concept is realized by enlarging the routing table entries to incorporate multicast group members as shown in Table 2, below. More specifically, a CM IP address is mapped to a plurality of RF port IDs (each of which represents a different CM) and a plurality of CM Tunnel IP addresses as illustrated in Table 2 by CM IP Address Z. This CM IP address is also know as the multicast group IP address.

TABLE 2. CMTS Routing Cache Table - Multicast/Broadcast

CM IP Address	RF Port ID	CM Tunnel IP Address
IP-Address X	RF Port ID #n	IP Address K
:	:	:
IP Address Y	RF Port ID #m	IP Address L
IP Address Z (multicast group 1)	RF port ID #x	IP Address M
	RF port ID #m	IP Address N
	RF Port ID #1	IP address O

As shown in Table 2, three RF ports (with identifications #x, #m and #l) are associated with multicast group 1. Note that an RF port can be associated to both unicast and multicast connections simultaneously. When a CM needs to send data to all members of a group, it may do so by using the destination address of the multicast group. The CMTS, after receiving such packets, forwards them over the RF ports indicated in the routing table. Multicast group management is performed as appropriate to each specific CATV MAC protocol, for instance, ADAPt+. In accordance with the invention, should there be a service disruption on the CDN, the downstream IP traffic to the multicast group is re-routed to the listed plurality of CM Tunnel IP Addresses, each of which correspond to a respective PSTN-side IP address of the respective CMs.

The foregoing merely illustrates the principles of the invention and it will thus be appreciated that those skilled in the art will be able to devise numerous alternative arrangements which, although not explicitly described herein, embody the principles of the invention and are within its spirit and scope.

For example, although the inventive concept was illustrated herein as being implemented with discrete functional building blocks, e.g., an HE router, the functions of any one or more of those building blocks can be carried out using one or more appropriately programmed processors, e.g., a digital signal processor. Similarly, although the inventive concept was described in the context of using a CM and CMTS as a router, the invention is also applicable to networks in which the CM and CMTS act as bridges, or repeaters. This requires that the CMTS be able to resolve a MAC address of a home appliance from the IP address of the home appliance. As such, routing table requirements grow proportionally to the number of home appliances to be supported.

Also, the inventive concept is applicable to other residential access technologies such as Asymmetric Subscriber Digital Link (ADSL), Passive Optical Networks (PON), wireless networks, satellite networks, etc.

What is claimed:

1   1. A method for use in providing Internet service to an endpoint, the method
2   comprising the steps of:
3   specifying routing information for an endpoint, wherein the routing information
4   specifies primary and alternative Internet Protocol (IP) addresses; and
5   communicating data to the endpoint using the specified primary IP address except
6   during periods of service interruption in which one of the alternative IP addresses are
7   used.

1   2. The method of claim 1 wherein the communicating data step further comprises
2   the steps of:
3   detecting the service interruption;
4   establishing an IP tunnel to the endpoint using one of the alternative IP addresses;
5   and
6   forwarding the data via the IP tunnel to the endpoint.

1   3. The method of claim 1 wherein the communicating data step further comprises
2   the steps of:
3   receiving an IP packet that includes a destination field, the value of which matches
4   a subnetwork address identifier within the primary IP address;
5   determining if a communications channel to the primary IP address is available;
6   if the communications channel is available, routing the received IP packet to the
7   primary IP address; and
8   if the communications channel is not available, routing the received IP packet to
9   one of the alternative IP addresses.

1   4. A method for use in providing Internet service to an endpoint via a primary
2   communications channel, the method comprising the steps of:
3   storing a routing table comprising an first Internet Protocol (IP) address associated
4   with routing data to an endpoint via the primary communications channel and a second IP
5   address associated with routing data to the endpoint over a secondary communications
6   channel; and
7   routing data to the endpoint as a function of the routing table such that during
8   periods of service interruption on the primary communications channel data is routed to
9   the endpoint via the secondary communications channel, whereas data is routed to the
10 endpoint via the primary communications channel otherwise.

1   5. The method of claim 4 wherein the routing data step further comprises the

2   steps of:

3   detecting the service interruption;

4   establishing an IP tunnel to the endpoint using the second IP address;

5   and

6   forwarding the data via the IP tunnel to the endpoint.

1   6. The method of claim 4 wherein the routing data step further comprises the

2   steps of:

3   receiving an IP packet that includes a destination field, the value of which matches

4   a subnetwork address identifier within the first IP address;

5   determining if the primary communications channel is available;

6   if the primary communications channel is available, routing the received IP packet

7   to the first IP address; and

8   if the primary communications channel is not available, routing the received IP

9   packet to the second IP address.

1   7. A method of communicating over a cable television (CATV) access network

2   having a cable modem termination system (CMTS) interface, the method comprising the

3   steps of:

4   establishing a connection between the CMTS and a distant cable modem (CM);

5   storing routing information associated with the connection, the routing information

6   including at least a CM identifier, an identity of an RF link on the CATV access network

7   over which the CMTS forwards data packets to the CM, and a tunnel interface identifier

8   over which the CMTS forwards data packets to the CM over a different network; and

9   communicating data packets to the CM by translating the CM identifier to either

10   the identified RF link or the tunnel interface identifier, wherein the tunnel is invoked in the

11   event of a CATV interface failure.

1   8. The method of claim 7 wherein CATV access network provides one-way, or

2   downstream, communications to the CM.

1   9. The method of claim 7 wherein CATV access network provides two-way

2   communications to the CM.

1   10. The method of claim 7 wherein the CM identifier over the CATV network is

2   logically derived from a CMTS subnetwork identifier of the CMTS.

11. The method of claim 7 wherein the CM identifier over the different network is logically derived from an Internet Service Provider (ISP) subnetwork identifier of a Network Access Server (NAS) of the ISP.

12. Apparatus for use in providing Internet service to an endpoint, the apparatus comprising:

a device for (a) specifying routing information for an endpoint, wherein the routing information specifies primary and alternative Internet Protocol (IP) addresses, and (b) communicating data to the endpoint using the specified primary IP address except during periods of service interruption in which one of the alternative IP addresses are used.

13. The apparatus of claim 12 wherein the device is a part of a cable television network (CATV).

14. Apparatus for use in providing Internet service to an endpoint, the apparatus comprising:

a device for routing data to the endpoint as a function of a routing table stored therein such that during periods of service interruption on a primary communications channel data is routed to the endpoint via a secondary communications channel, whereas data is routed to the endpoint via the primary communications channel otherwise.

15. The apparatus of claim 14 wherein the device is a part of a cable television network (CATV).

16. A system for use in providing Internet service, the system comprising:

a cable head-end router for providing Internet Protocol (IP) packets intended for subsequent conveyance over a primary channel; and

a cable modem data termination system responsive to the provided IP packets for routing the IP packets to an endpoint as a function of a routing table stored therein such that during periods of service interruption on the primary communications channel the IP packets are routed to the endpoint via a secondary communications channel, whereas the IP packets are routed to the endpoint via the primary communications channel otherwise.

17. A system for use in providing Internet service, the system comprising:

a cable head-end router for providing Internet Protocol (IP) packets that include a destination field having a value associated with a first IP address; and

a cable modem data termination system responsive to the provided IP packets for communicating the IP packets to the endpoint using the first IP address except during periods of service interruption in which an alternative IP address is used.

Abstract

A user accesses the Internet through a hybrid data communications system architecture in which upstream service is provided via the local loop of the public switched telephone network (PSTN) and downstream service is provided via a cable television (CATV) network. The Cable Modem Data Termination system (CMTS) includes a routing table. Upon detection of a CATV service interruption, the CMTS re-routes IP traffic destined for a destination IP address (IP1) associated with the user to a different IP address, or endpoint, as a function of the routing table. In this instance, the different IP address is associated with equipment that provides downstream IP service to the user via the local loop of the PSTN.

5

10

FIG. 1

100

FIG. 2

PC   110

IP
802.3
10BaseX

CM   115

IP		
ARP	PPP	MAC_HFC
802.3	POTS	PHY_HFC
10BaseX		

CMTS   120

IP	
MAC_HFC	802.3
PHY_HFC	100BaseX

HE router   125

IP	
802.3	ATM
100BaseX	SONET

NAS   145

IP	
PPP	ATM
POTS	SONET

PSTN 140

Internet 180

FIG. 3
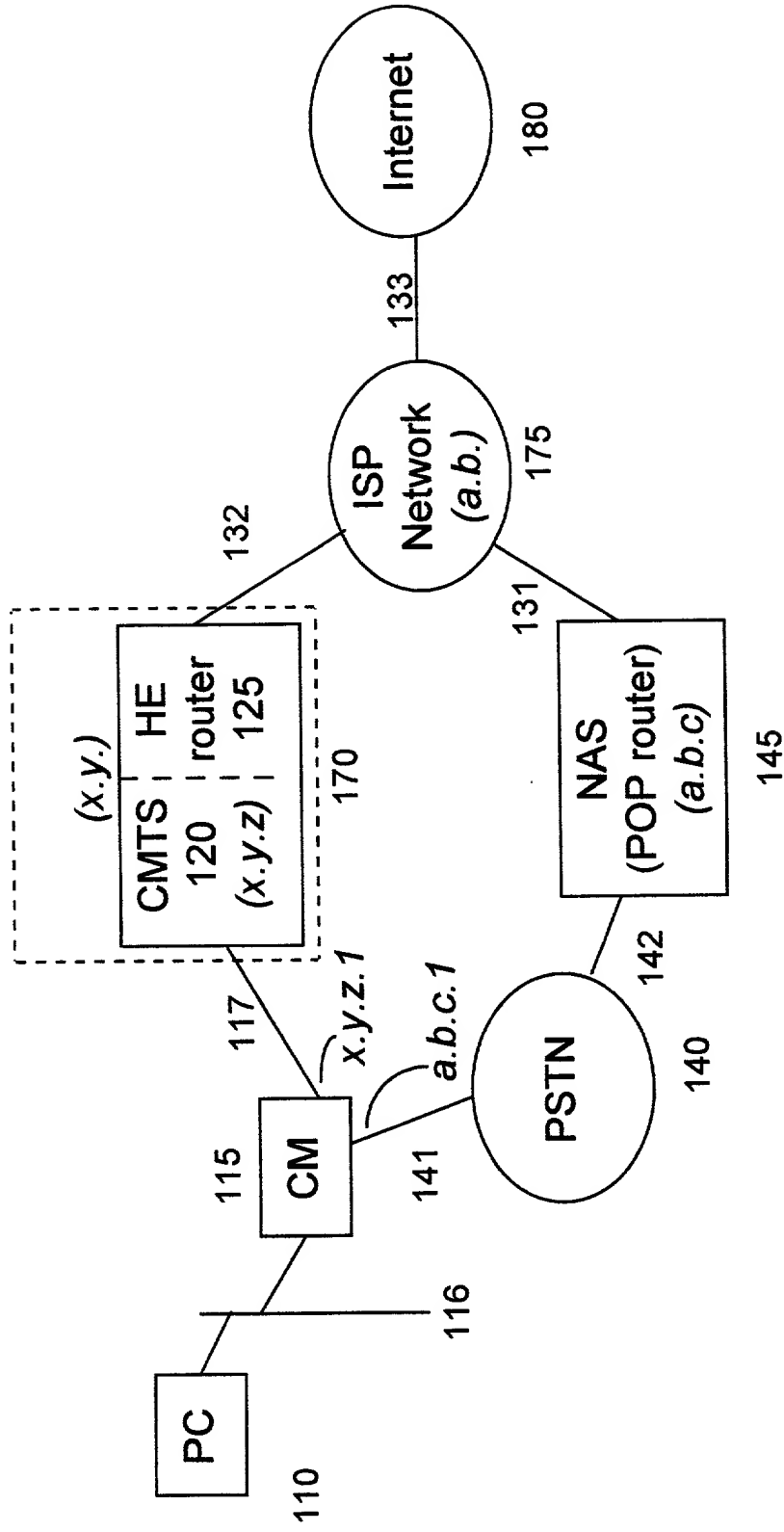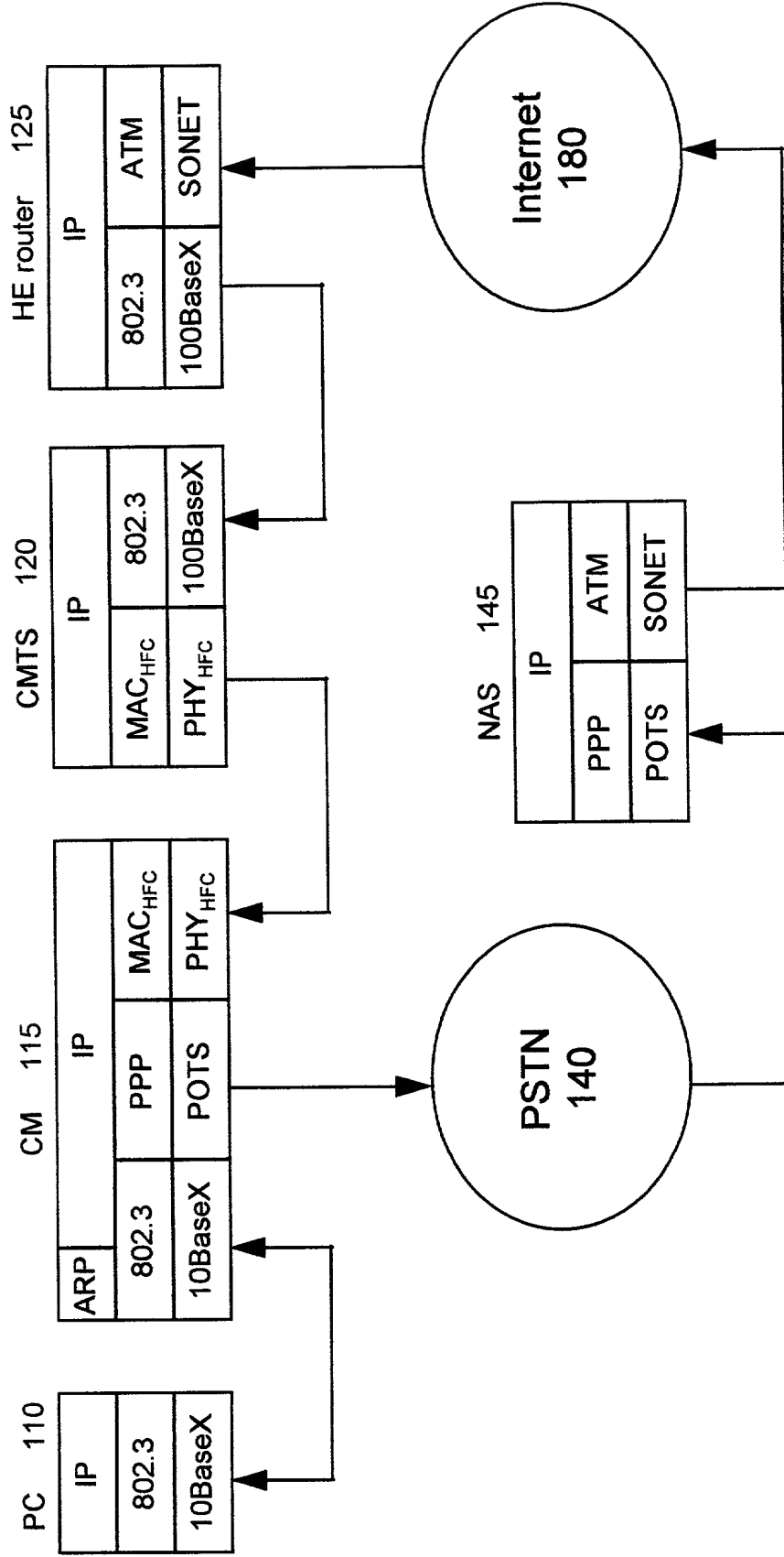
start

detect service interruption

establish IP tunnel to the cable modem

forward traffic via the IP tunnel

end

305

310

315

FIG. 4

355

350

CMTS IP Subnetwork identification match ?

start

No → Discard

Yes

CM IP Subnetwork identification match ?

No → Discard

Yes

360

RF port working ?

Yes → route packet to CM

No → re-route packet to alternate IP address for the CM
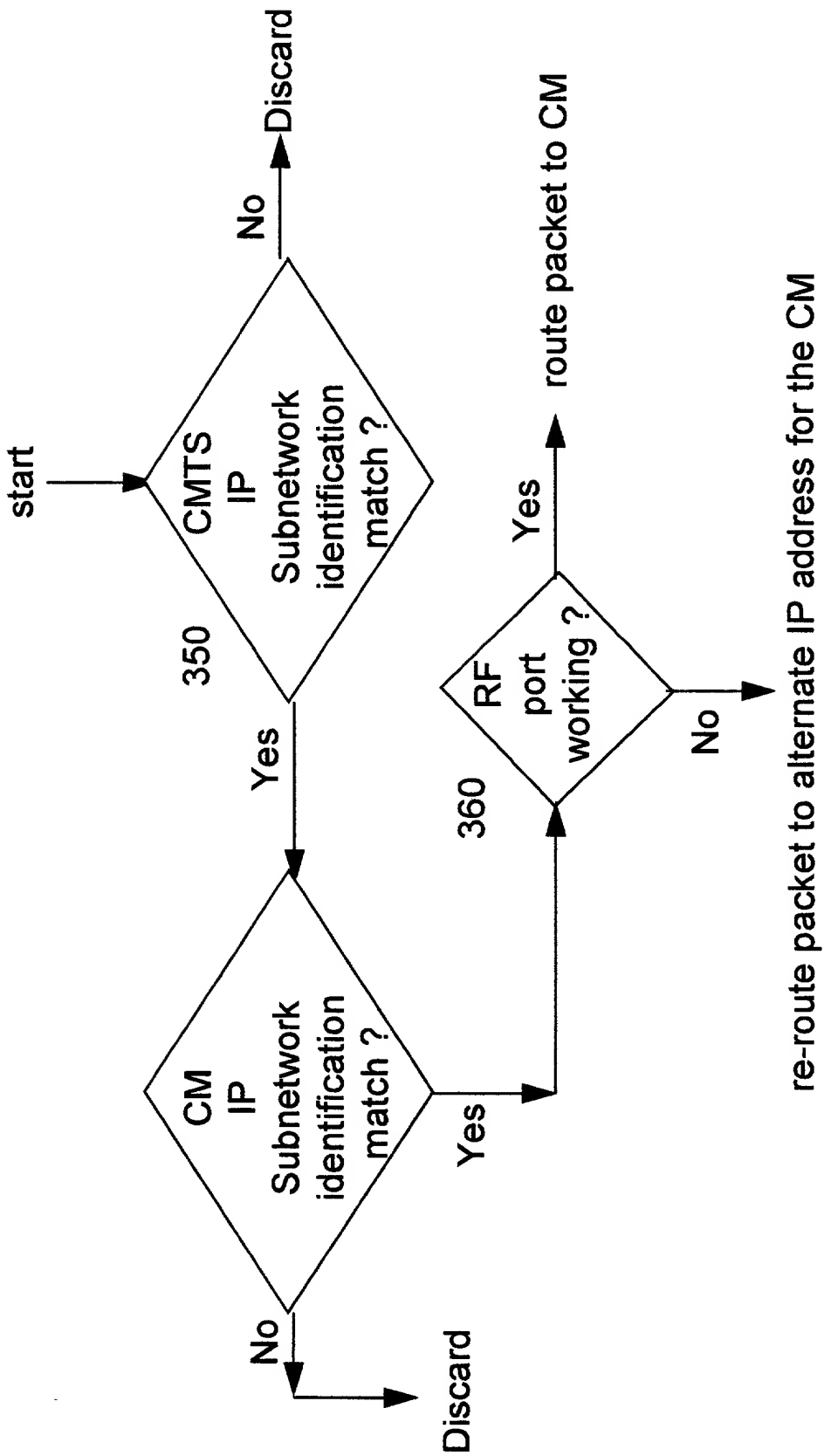
IN THE UNITED STATES
PATENT AND TRADEMARK OFFICE

Declaration and Power of Attorney

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am an original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled **Internet Protocol Based Network Architecture For Cable Television Access with Switched Fallback** the specification of which was filed on December 16, 1997, as application Serial No. 08/991735.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by an amendment, if any, specifically referred to in this oath or declaration.

I acknowledge the duty to disclose all information known to me which is material to patentability as defined in Title 37, Code of Federal Regulations, 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

None

I hereby claim the benefit under Title 35, United States Code, 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

None

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

I hereby appoint the following attorney(s) with full power of substitution and revocation, to prosecute said application, to make alterations and amendments therein, to receive the patent, and to transact all business in the Patent and Trademark Office connected therewith:

Steven R. Bartholomew	(Reg. No. 34771)
Lester H. Birnbaum	(Reg. No. 25830)
Richard J. Botos	(Reg. No. 32016)
Jeffery J. Brosemer	(Reg. No. 36096)
Kenneth M. Brown	(Reg. No. 37590)
James A. DiGiorgio	(Reg. No. 36980)
Donald P. Dinella	(Reg. No. 39961)
Martin I. Finston	(Reg. No. 31613)
James H. Fox	(Reg. No. 29379)
Julio A. Garceran	(Reg. No. 37138)
Mony R. Ghose	(Reg. No. 38159)
Jimmy Goo	(Reg. No. 36528)
Anthony Grillo	(Reg. No. 36535)
John M. Harman	(Reg. No. 38173)
Donald E. Hayes Jr.	(Reg. No. 33245)
Irena Lager	(Reg. No. 39260)
Frederick B. Luludis	(Reg. No. 26299)
Christopher N. Malvone	(Reg. No. 34866)
Scott W. McLellan	(Reg. No. 30776)
Geraldine Monteleone	(Reg. No. 40097)
John C. Moran	(Reg. No. 30782)
Michael A. Morra	(Reg. No. 28975)
Gregory J. Murgia	(Reg. No. 41209)
Claude R. Narcisse	(Reg. No. 38979)
Katharyn E. Olson	(Reg. No. 37693)
Joseph J. Opalach	(Reg. No. 36229)
Neil R. Ormos	(Reg. No. 35309)
Eugen E. Pacher	(Reg. No. 29964)
Jack R. Penrod	(Reg. No. 31864)
Daniel J. Piotrowski	(Reg. No. P-42079)
Gregory C. Ranieri	(Reg. No. 29695)
John T. Rehberg	(Reg. No. 29207)
Scott J. Rittman	(Reg. No. 39010)
Eugene J. Rosenthal	(Reg. No. 36658)
Bruce S. Schneider	(Reg. No. 27949)
Ronald D. Slusky	(Reg. No. 26585)
David L. Smith	(Reg. No. 30592)
Patricia A. Verlangieri	(Reg. No. P-42201)
John P. Veschi	(Reg. No. 39058)
David Volejnicek	(Reg. No. 29355)
Charles L. Warren	(Reg. No. 27407)
Eli Weiss	(Reg. No. 17765)

Please address all correspondence to the Docket Administrator (Rm. 3C-512), Lucent Technologies Inc., 600 Mountain Avenue, P. O. Box 636, Murray Hill, New Jersey 07974-0636. Telephone calls should be made to Joseph J. Opalach by dialing 732-949-1708.

Full name of 1st joint inventor: Donald Edgar Blahut

Inventor's signature _____ Date 3/20/98

Residence: Holmdel, Monmouth County, New Jersey

Citizenship: United States of America

Post Office Address: 9 Stevens Drive
                              Holmdel, New Jersey   07733

Full name of 2nd joint inventor: James D. Bobeck

Inventor's signature_____ Date 3-20-98

Residence: Leesport, Berks County, Pennsylvania

Citizenship: United States of America

Post Office Address: 1047 Mahlon Drive
                                 Leesport, Pennsylvania   19533

Full name of 3rd joint inventor: Robert William Dalton

Inventor's signature _____ Date __3/23/98__

Residence: North Andover, Essex County, Massachusetts

Citizenship: United States of America

Post Office Address: 27 High Plains Road
                                 North Andover, Massachusetts   01845

Full name of 4th joint inventor: Enrique Hernández-Valencia

Inventor's signature_____Date 3/19/98

Residence: Highlands, MONMOUTH County, New Jersey

Citizenship: Venezuela

Post Office Address: 78 Valley Avenue
                               Highlands, New Jersey   07732

Full name of 5th joint inventor: Roger Henry Levy

Inventor's signature_____ Date April 20, 1998

Residence: Twp. of Berkeley Heights, Union County, New Jersey

Citizenship: United States of America

Post Office Address: 43 Webster Drive
                              Berkeley Heights, New Jersey   07922

D.E. Blahut 43-4-2-2-3-6

Full name of 6th joint inventor: Ronald L. Sharp

Inventor's signature _____ Date Apr 1, 1998

Residence: Califon, County, New Jersey

Citizenship: United States of America

Post Office Address: Rr2 Box 245 Gary Lane
                               Califon, New Jersey   07830